Dynamic Effects in Tevatron Dipoles

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& the MTF operations & maintenance team

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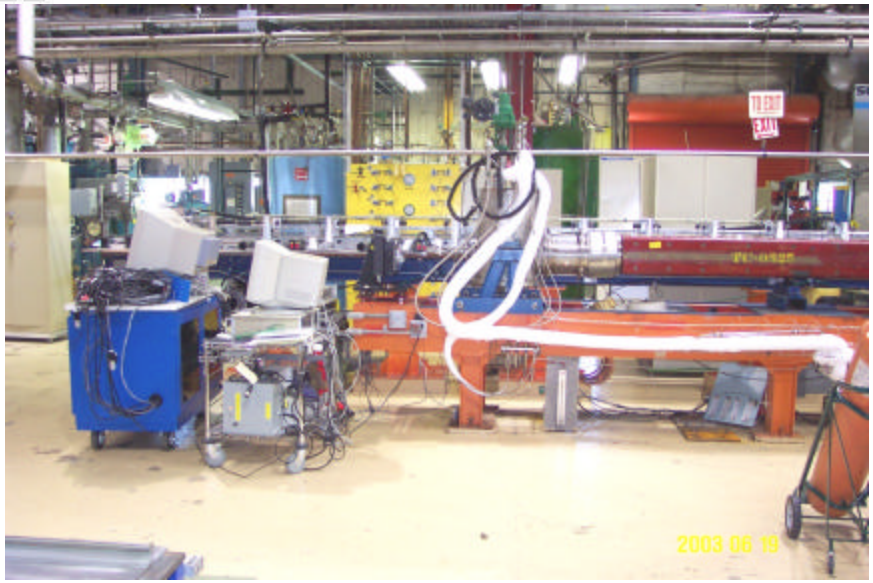
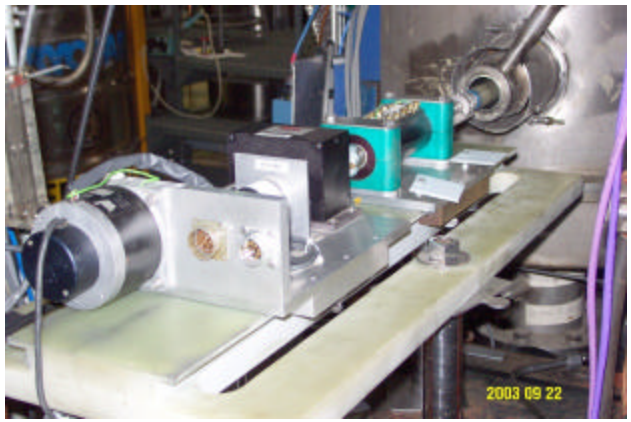
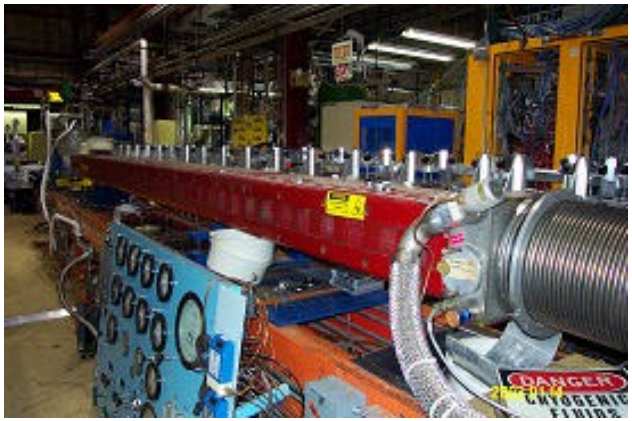
Acknowledgment

MTF – Tevatron Test Stands

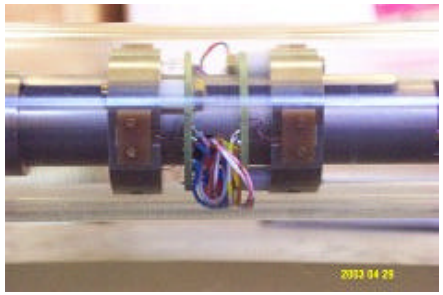




Rotating Coils

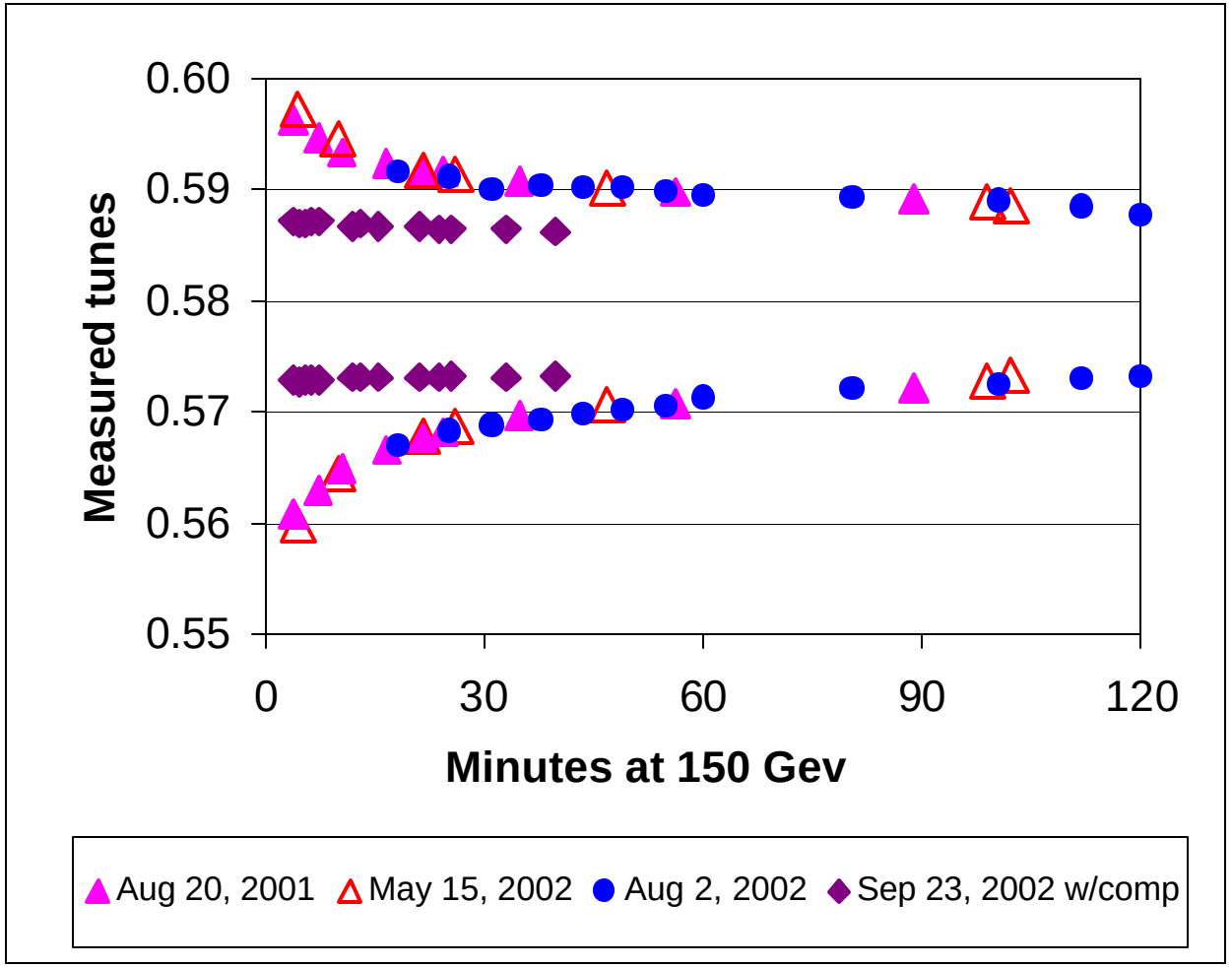


Tevatron stand 4



Sextupole Hall probe array

Motivation



M. Martens and J. Annala

Tune & Coupling drift in Tevatron – reminiscent of chromaticity drift in magnets!

TD launched a magnet study to search for drifting a1 and b1 in Tevatron dipoles or quadrupoles!

Magnitude of effect: 0.1 / 2 (units) drift over 1 hour in all dipoles / quadrupoles!

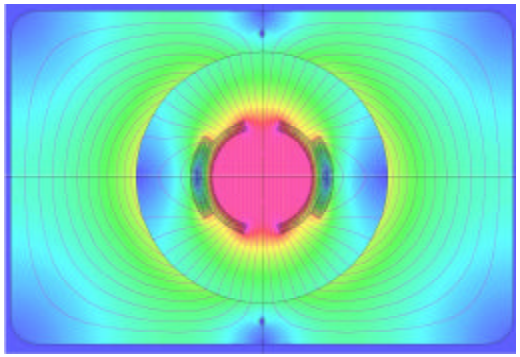
Basics on Tevatron Dipole Magnets

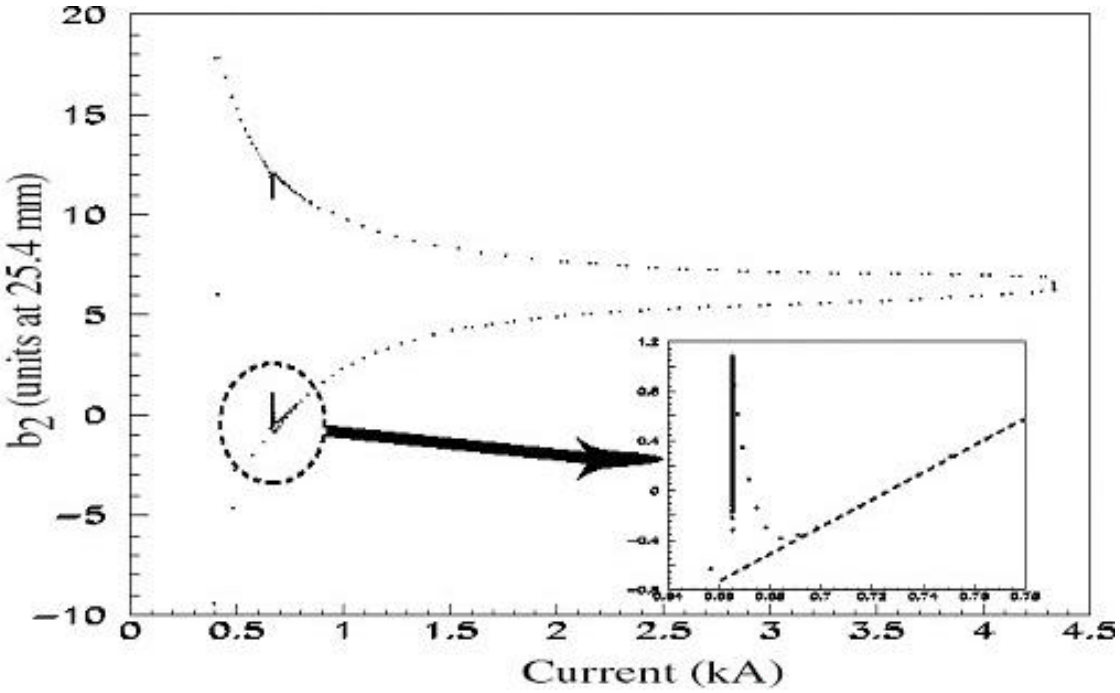
“geometric fields”

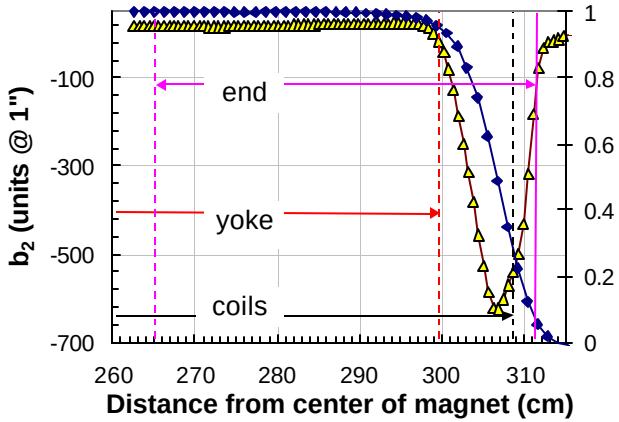
dipole	~1mT/A
sextupole	14.4u / -600u
decapole	1.8u / -80u
18-pole	-12.5u / -12.5u

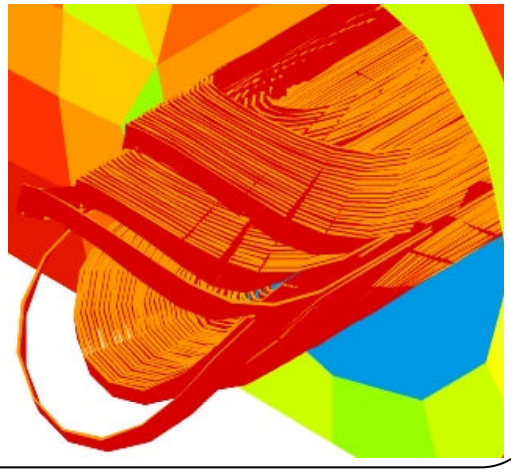
“hysteretic loops”

dipole	width ~20 u inj
sextupole	width ~10 u inj

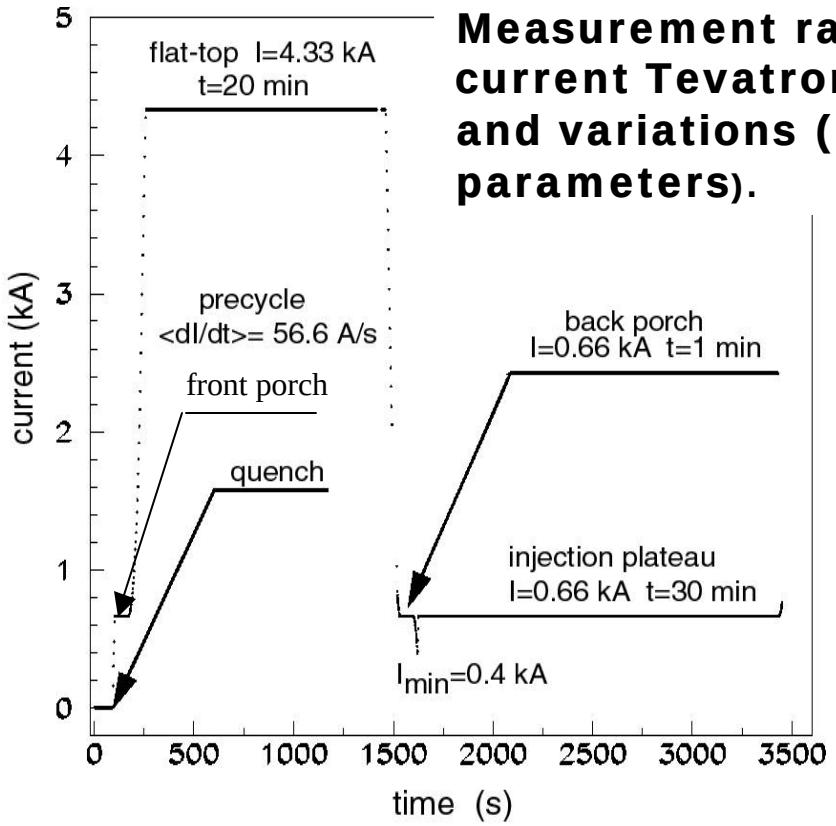






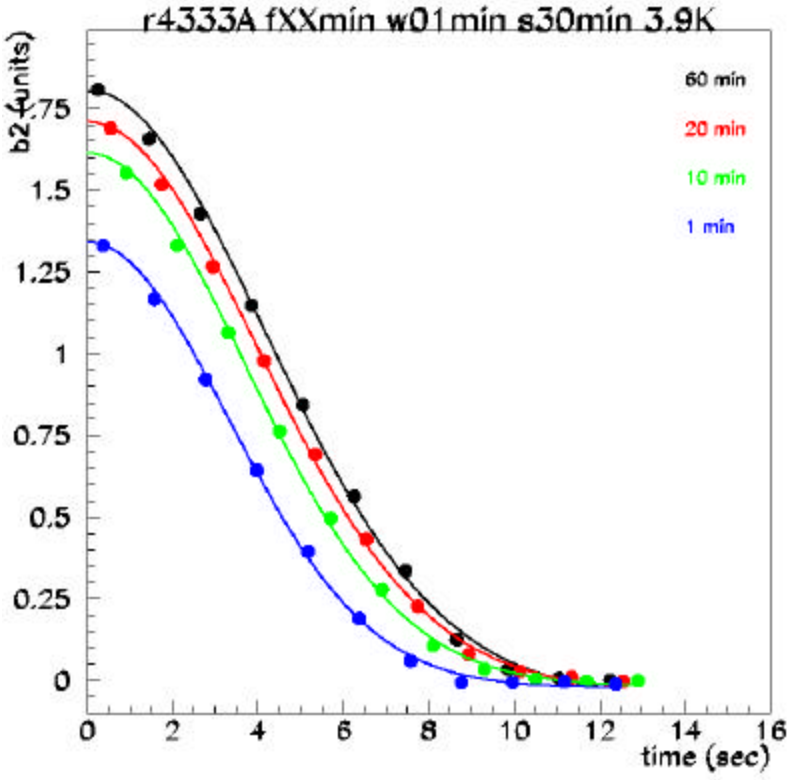


Dipole Measurement Program



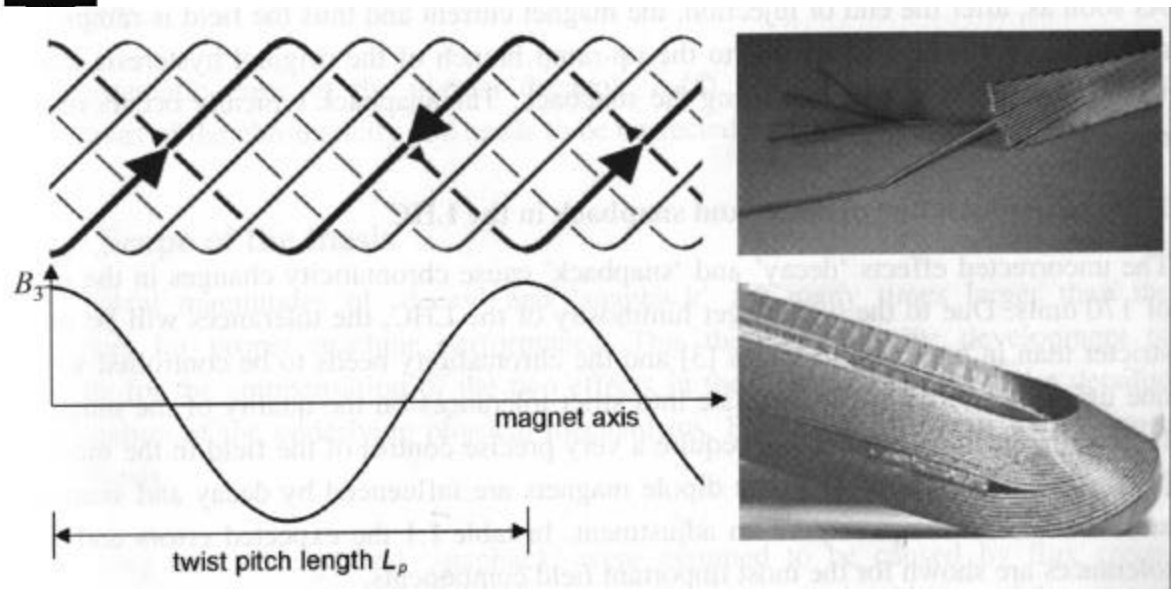
Measurement ramping cycle = current Tevatron operation cycle and variations (of the pre-cycle parameters).

TC0483	TC1052
TB0834	TB1055
TB0269	TB1198
TC1220	TB710
TC0525	

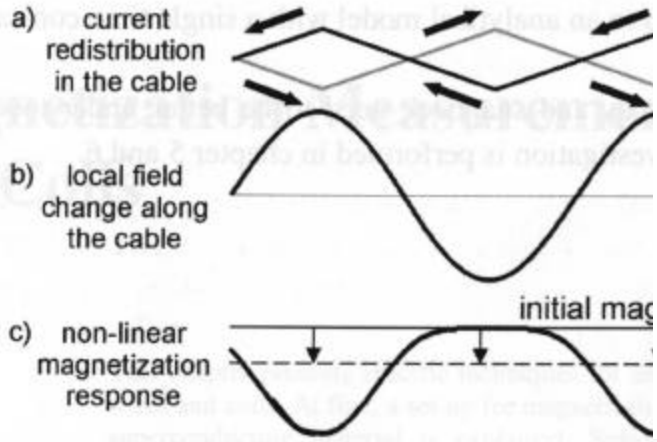


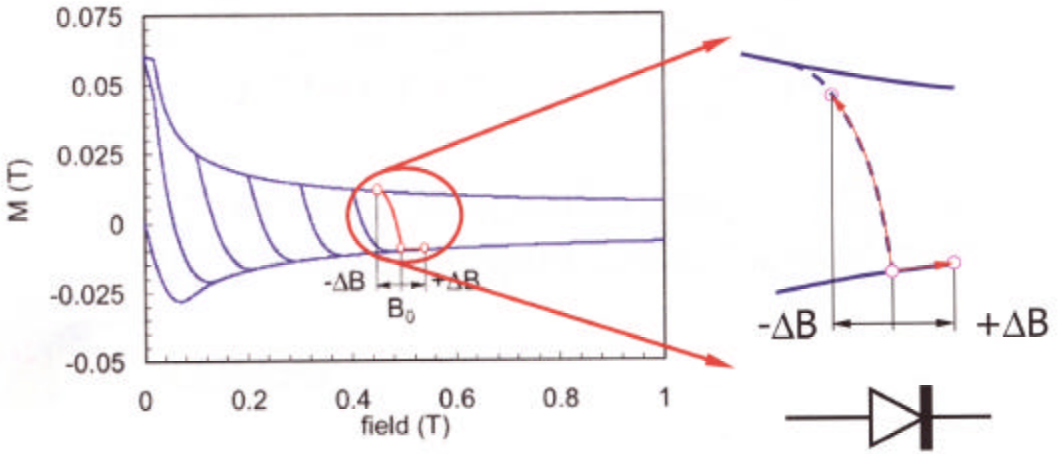
Parameters varied: front-porch, flat-top, back-porch, injection porch, FT energy, # of pre-cycles, probe position, magnet temp.

Qualitative Model of Dynamic Effects



Uneven current distributions across strands in the cable produce time varying "pattern". At constant excitation in magnet it brings out non-linear magnetization effects – drift and snapback.

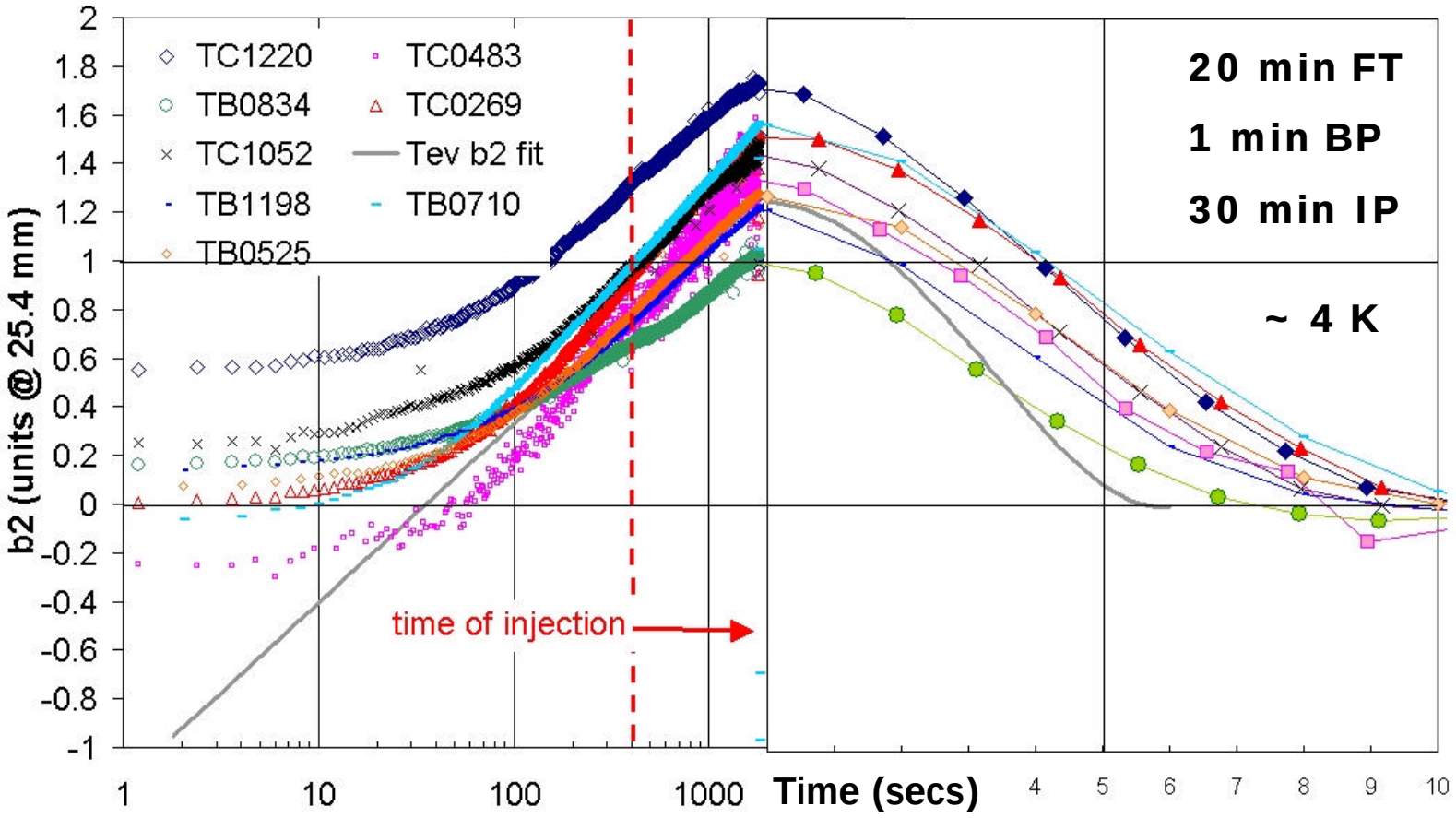




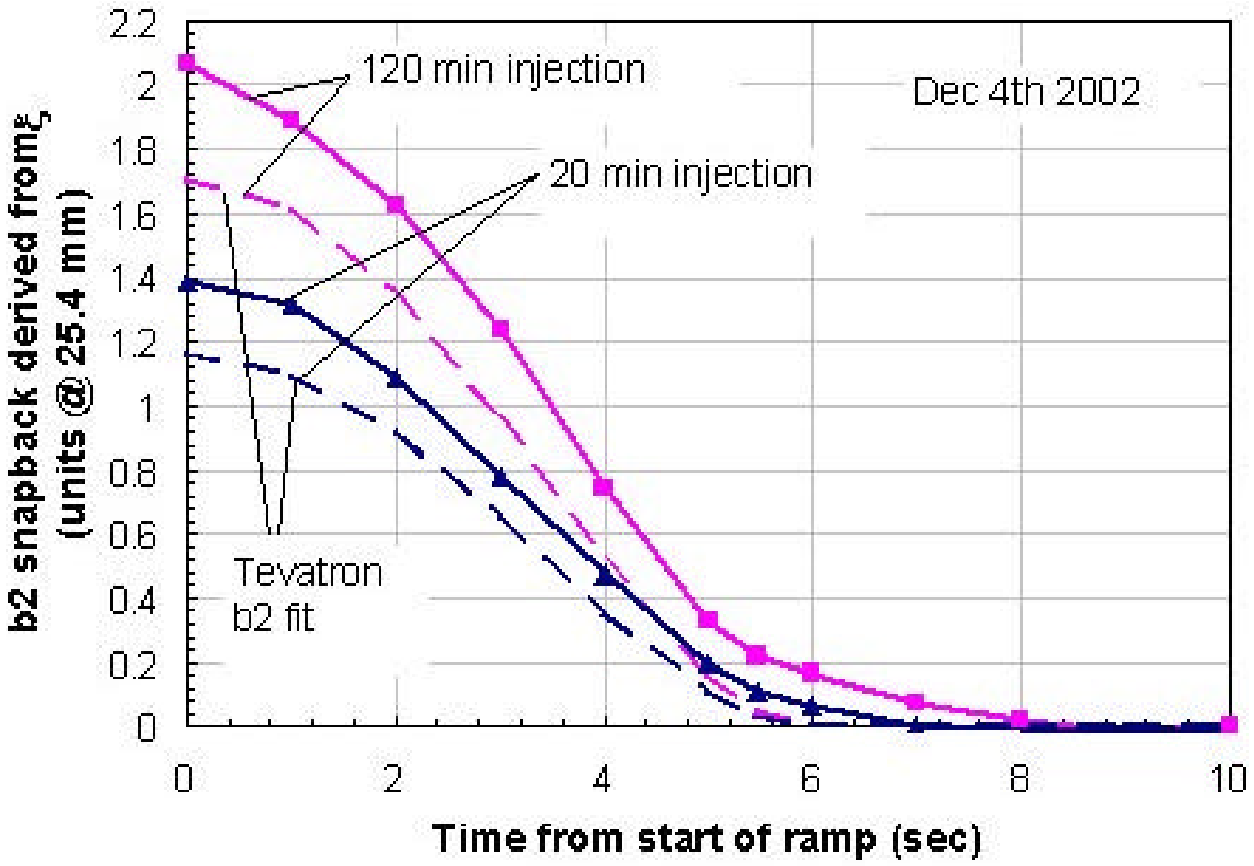
Courtesy of M. Haverkamp, L. Bottura

Dynamic b2 in Tevatron Dipoles: Drift and Snapback in 1-20-1 Case

dynamic b2: 1-2 u drift in 30 mins at inject., log dependence; magnet-to-magnet spread; dependence on powering "history" –see standard case below:



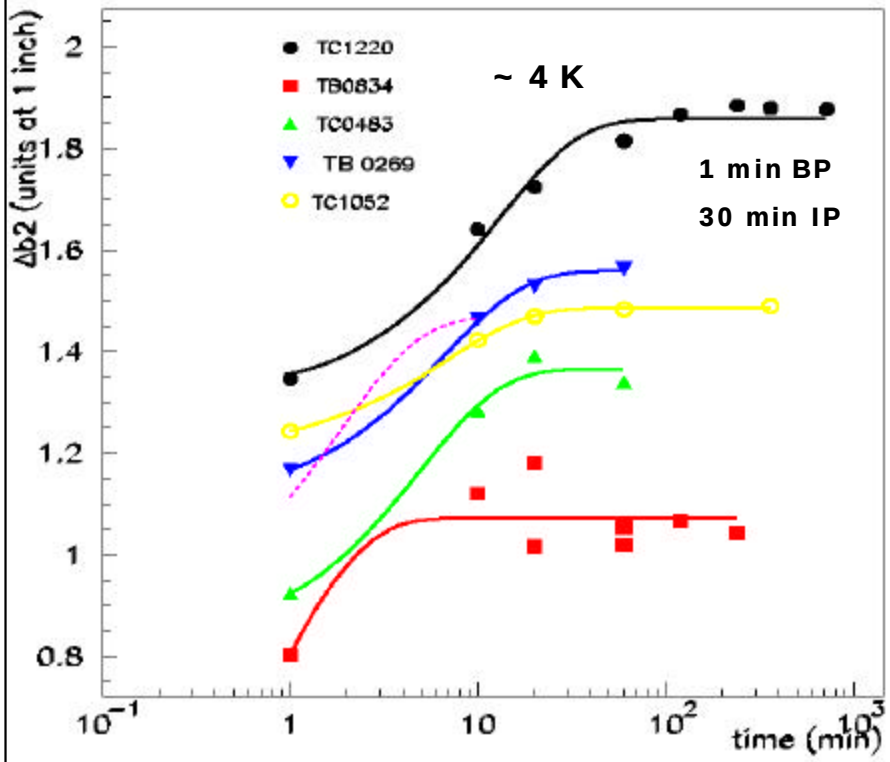
Beam Based Measurements –b2 Snapback



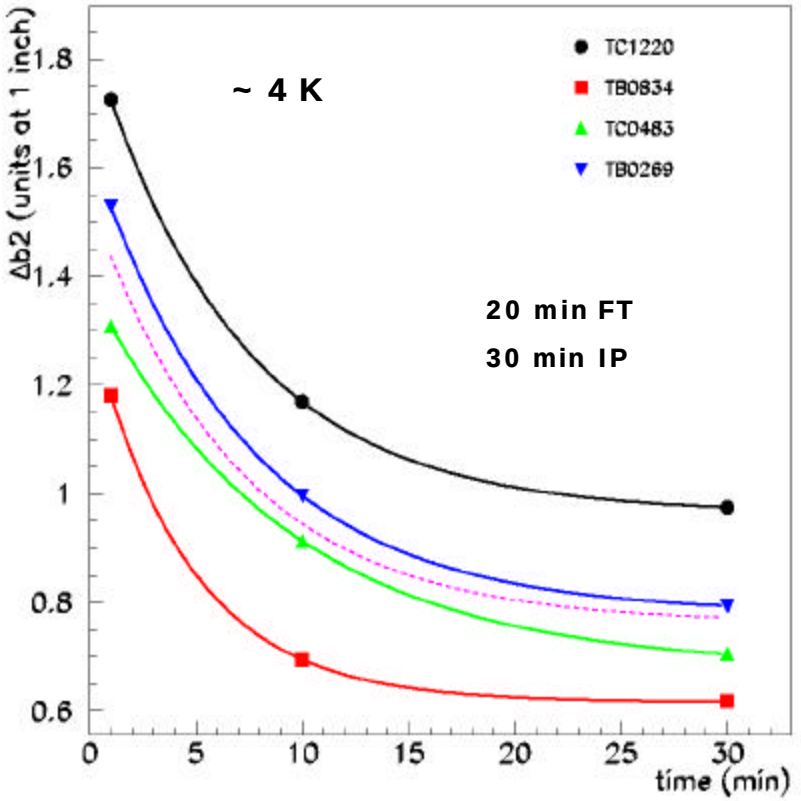
- **Measured SB longer than predicted by fit**
- **drift amplitude larger than predicted by fit**
- **First study: ~0.5 unit error?**

Average Tevatron dipole b2 SB after 20 & 120 min injection porch, derived from measured beam chromaticity (dashed: b2 compensation)

Effect of Main Operational Parameters on Dynamic b2 – Flattop and BackPorch Duration



Effect of flat-top duration;



Effect of back-porch duration;

Proposals for Improved Dynamic b2 Feed Forward Correction in the Tevatron

1) Fix (and extend) back-porch time

2) Reduce # of beam-less pre-cycles following a Tevatron quench from 6 to 1 (min 40 min flat-top);

3) Change b2 SB fit® Gaussian

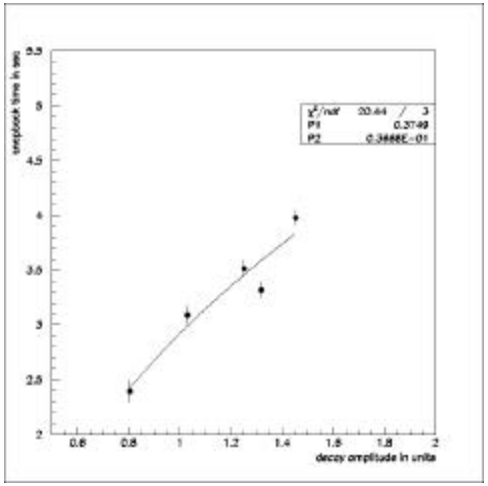
4) saturation of flat-top duration effect on drift amplitude and absence of effect of front-porch duration ® Eliminate pre-cycle

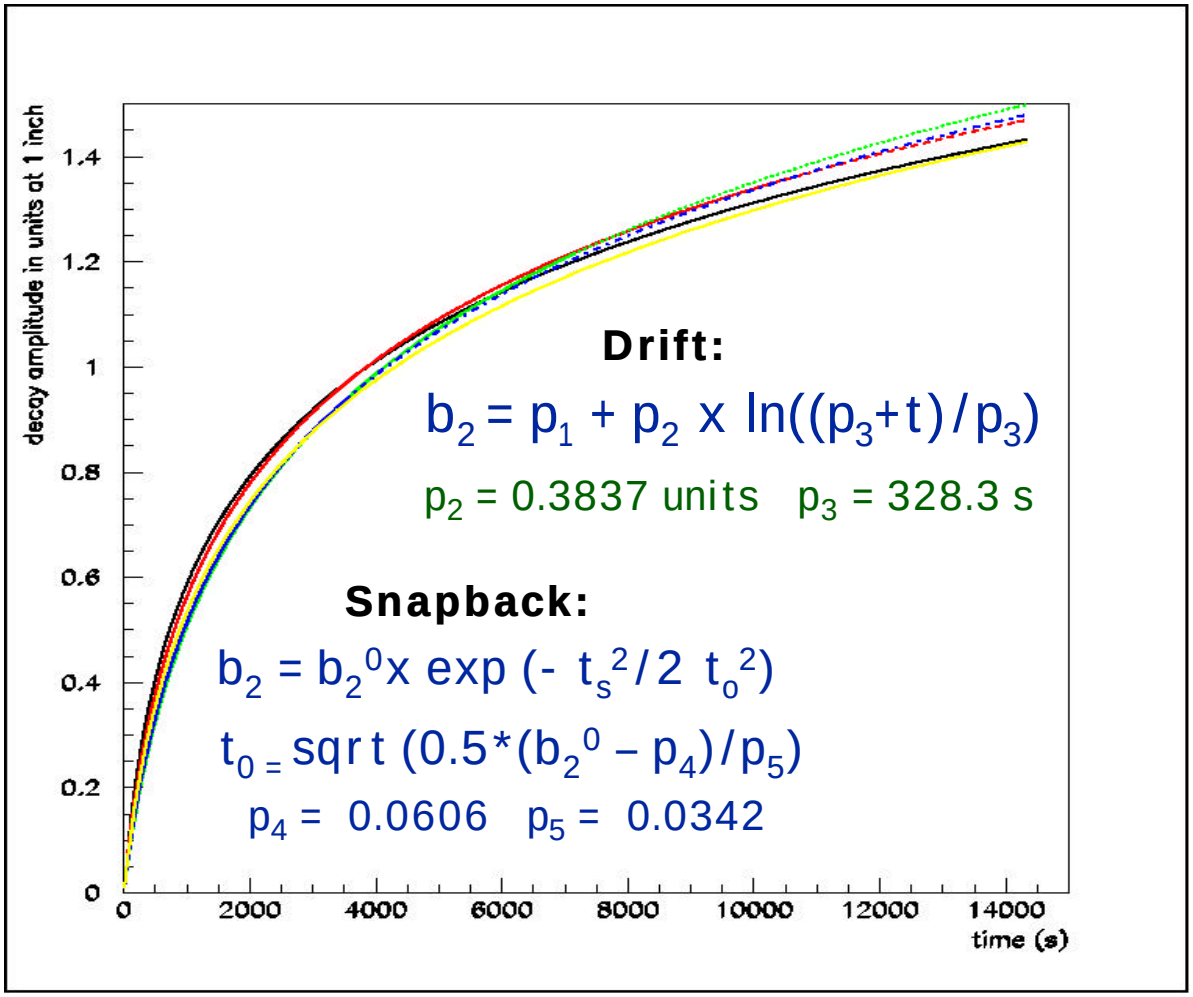
5) Improve drift fit – a parameter in the old fit is history dependent although it shouldn't be, a double exponential appears to be slightly better than the log fit.

b2 Beam Study in Preparation

Test new Tevatron b2 correction for:

- **5 min back-porch**
- **no pre-cycle (directly from store to injection)**

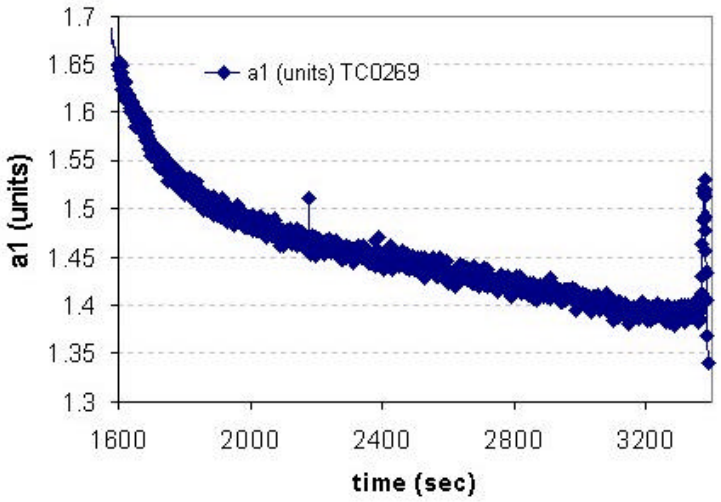




Plot of 1055 drift for 5 min back-porch duration

Other Related Study Topics:

Normal and skew quad drifts



- Drifts in higher mps (b4,..)
- End-body differences
- Temperature effects

Main field drifts